IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Transformation Imperatives For The Armed Forces In The Era Of The Fourth Industrial Revolution Colonel Saurabh Bhatnagar

Saurabh Bhatnagar
Army Officer
Osmania University

Introduction

1. Technology occupies a pre-eminent position as the arbiter of destinies in the history of warfare. Whether it was the first metal smith who forged a sword & a shield, the innovative soldier who strung a bow, the herdsman who put a saddle & a stirrup on a horse or the chemist who used the power of gun powder to launch projectiles, these innovators gave their armies the decisive edge which their adversaries could not withstand. Thus was shaped the history of our world. Victors in wars have invariably been the Generals and Commanders who had the foresight to avail of the opportunity provided by advances in technology.

2. The pace of technological change in the 21st century has reached unprecedented levels and continues to accelerate. The primary drivers of change in today's world are the many rapidly emerging technologies which have moved from the realm of science fiction to reality in an exceptionally short time. Technologies such as Artificial Intelligence, Robotics, Quantum Computing, Nano-Technology and Biotechnology are rapidly remoulding the nature of human endeavour in all spheres. Once technology is available it is only a matter of time before it is used to gain a decisive military advantage. The 1899, Peace Conference at Hague, attended by all major powers placed a moratorium on the offensive military uses of aircraft. However, as the potential of aerial warfare became understood, the 2nd Hague Conference declined to extend the moratorium and within a short time air power became the cutting edge of military power. Present and future technologies are likely to follow similar trajectories. The danger is that sub consciously military leaders tend to project experiences of past wars forward and expect to fight along similar lines, however the rapidly evolving technologies imply that future wars may have very little in common with past ones. (David Barno, Nora Bensahel, 2018).

3. Between the first and second World Wars while Germany developed the Blitzkrieg doctrine predicated on new emergent technologies, the French kept busy developing the Maginot line (Liam Collins & Harrison Morgan, 2020). If the portent of the ensuing conflict is any indicator it is clear that it is of paramount importance that military leaders preparing for future wars achieve a clear understanding of emergent capabilities

enabled by upcoming technologies. Those leaders who fail to do so, run the risk of continuing to prepare their men for yesterday's wars and the consequences could be disastrous.

Technology and the Organisation

4. Harold Leavitt's Diamond (Leavitt, 1965) provides a simple model to understand complex organisations and the dynamics of change within them. As per Leavitt, all organisations are composed of four interdependent components; **People, Task, Structure** and **Technology**, Change in any one of these elements necessitates a corresponding change in the others, failing which the organization would become incoherent. In the 21st Century Technology has become the primary driver of change and is the shaping the environment relentlessly. Morgan has likened organisations to organisms, which must achieve an appropriate relationship with their environment, if they are to survive and flourish. (Morgan, 1986) In the context of the armed forces the environment driven by technology has evolved significantly in recent times and therefore the 'organism' too must evolve if it has to flourish. Organisations must race to adapt themselves to the march of technology. The alternative to adapting people, tasks and structure to the emergent technology is obsolescence and extinction and this is highly true for militaries. (Alden, 2017)

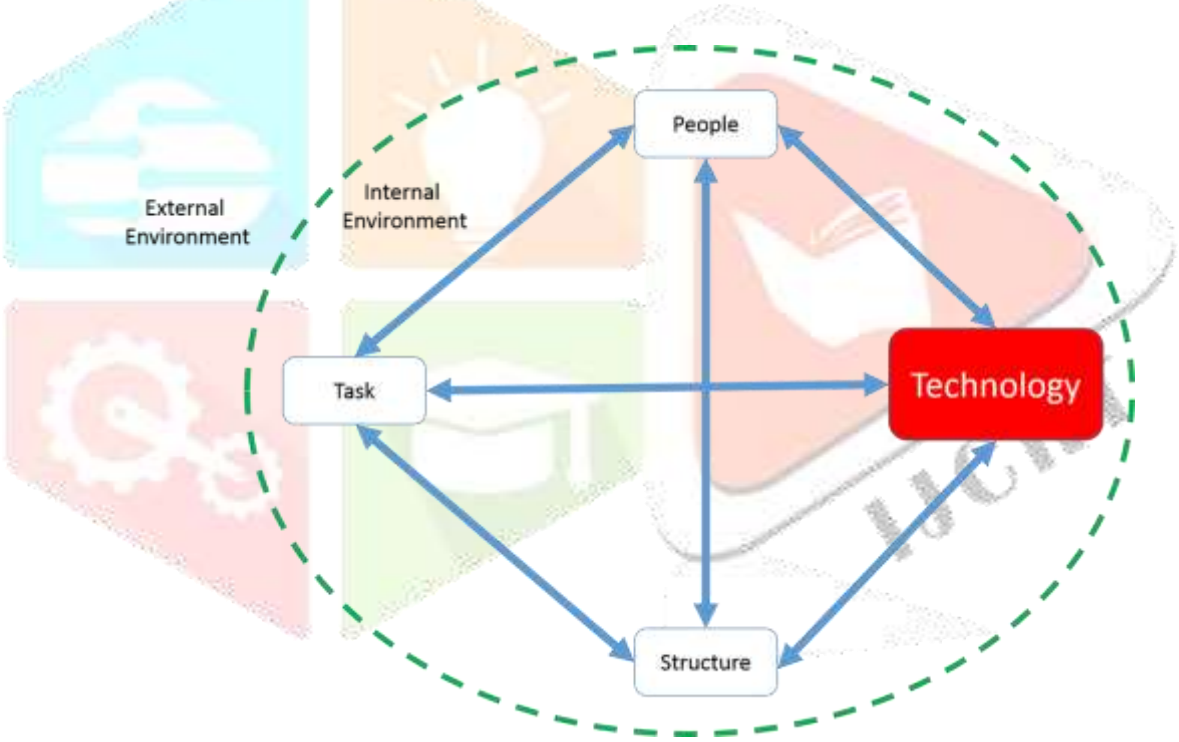

Figure 1: Components of the Organisation: Technology has emerged as the Primary Driver of Change

The Fourth Industrial Revolution

5. New technologies have historically been key triggers for radical change in social structures, polities and economic systems. When such changes have occurred in a relatively short period of time they are referred to as Revolutions. Starting with the Agrarian Revolution human history comprises of seminal changes which have continually redefined the essence of human civilization. Klaus Schwab has identified four key revolutions the first three of which have defined the modern world and the fourth which we are presently living through will shape our future. He terms them the Four Industrial Revolutions. (Schwab, 2017) The essence of these revolutions is depicted in figure 3.

Industrial Revolution	Period	Triggers	Outcome © S Bhatnagar 2021	Impact on Warfare
First	1760s – 1840s	Steam Engine Rail Road Global Shipping	Mechanical Production	• Improved Logistics; Increased Reach, Expanded Theatres of War • Invention of the rifle and refinement of mobile massed artillery
Second	1870s – 1950s	Electricity Oil; IC Engine Assembly Line Telegraph Aircraft	Mass Production	• Increased Firepower & Mobility • Mechanised Warfare • Opening of 3rd dimension (Air) to warfare
Third	1960s -- 1990s	Electronics IT Nuclear Power	Automated Production	• Precision Guidance • Long Range vectors • Battlefield Transparency • Weaponisation of space
Fourth	2000 – till date	Electronics IT Internet	Autonomous Production	• Autonomous Weapons • Return of Mass (Swarms) • Improved Decision Making

Fig 2: The Four Industrial Revolutions

6. **Moore's Law and the March of Technology**. Today's world from the smart phone in your hand to the latest Mars rover have been shaped by the phenomenal advances made in the technology of silicon transistors – the ubiquitous chip. For over half a century, the tiny silicon switches have unleashed power barely imaginable and it is not incorrect to say that their proliferation has incredibly altered all major fields of human endeavor. Their impact on human history is no less seminal than any great political or social revolution. Gordon Moore, the founder of the path-breaking Fairchild Semiconductor and later Intel in Silicon Valley has given us the defining insight with respect to not only how these magical chips have impacted technology so far but also

how they will continue to do so in the future. Moore while working for Nobel Laureate William Shockley at a top Defence Lab uncovered the possibility of a printed silicon chip which he soon converted into a business opportunity and thus was born the microchip. He envisaged that microchips could double in power in a clockwork fashion over and over again and this would make electronics immensely cheap and powerful. (Arnold Thackray, David C Brock, Rachel Jones, 2015)

7. This gave us what has come to be known as Moore's Law, which in its most popularly accepted avatar states that:-

"The Computing Power of Microchips Doubles every Two Years"

8. **An Indian Fable & the Exponential Magic of Moore's Law**. By itself the statement of Moore's Law seems benign. But within itself, it hides the promise of unleashing fascinating and even intimidating power. Ray Kurzweil explains the mind boggling magnitude of the exponential growth in the power of microchips with the help of an Indian fable. (Kurzweil, 2000) He tells us of the clever man who invented the modern game of chess with its 64 squares based on the ancient Indian game of Chaturanga. The inventor travelled to Pataliputra and presented his invention to the scion of the Gupta empire. Suitably impressed by the difficult and beautiful game the emperor granted him a wish. The inventor praised his king's generosity and said "all that I wish for is some rice to feed my family and since the king so appreciates my invention why don't we use the chessboard to determine the amount of rice". And so he requested that one grain of rice be placed on the first square, two on the second, four on the third and so on doubling it all the way to the 64th square. The emperor impressed by the modesty of the inventor granted his wish with flair. What the emperor did not realise is that he had just made a promise he could not fulfill, for that amount of rice (approximately eighteen quintillion grains) has not been produced in the history of mankind, a pile of that rice would dwarf Mount Everest. Such is the power of exponential growth.

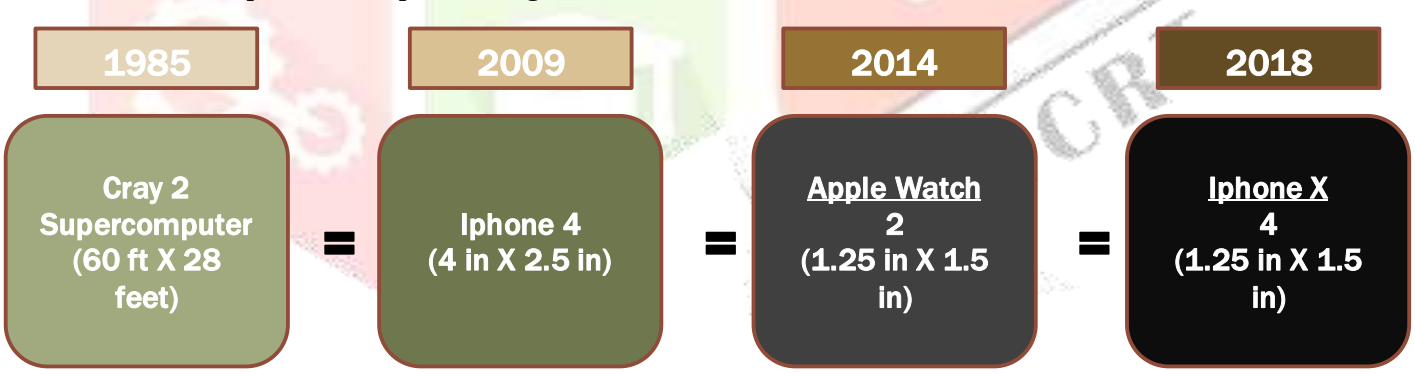

Fig 3: Today's smartphone has put in our palm the equivalent of four supercomputers of the late 1980's which occupied space worth a tennis court and guzzled enormous amounts of power

9. At the halfway mark or the 32nd square the emperor had committed 4 billion grains of rice, which are equivalent of one large field which for an emperor is all right. But once they entered the second half of the chess board with every iteration the numbers crossed trillions, quadrillions and quintillions, numbers which are beyond human comprehension.

10. The analogy with Moore's Law is interesting. The US Bureau of Economic Analysis, accepted Information Technology as a separate business category in the year 1958. (Erik Brynjolfsson & Andrew McAfee, 2016) If that year is taken as the start point of the Moore's Effect, we are now into the 32nd iteration of

exponential growth in the power of microchips. Already the strides computing power is making year on year is significant, but if Moore's Law continues to play out as it has over the past 61 years, magical things can be expected in the world of technology. In order to put things into perspective we may consider how the chip has already shrunk technology. The ASCI Red supercomputer of the 1990's cost $55 million and occupied space almost as large as one tennis court and was a power guzzler. It was dedicated to singular tasks such as simulating nuclear explosions. In less than ten years the Sony Play Station had matched its computing power at a miniscule fraction of its cost ($500) and energy requirement. (Erik Brynjolfsson & Andrew McAfee, 2016) Today's smartphones that sit comfortably in our hands far outstrip its computing power and perform multiple functions with ease. Google established that by 2012, a single Google search was equivalent to the entire computing done for the Apollo Moon programme. (Udi Manber, Peter Norvig, 2012) All pathbreaking technological developments of our times have a key feature: the leveraging of digital power. AI, Advanced Robotics, Big Data, Gene Sequencing, 3D Printing & discovery of New Materials are all driven by digitized processing of data.

11. **Mega Trends of the Fourth Industrial Revolution**. As Moore's Law continues to take effect and the ever more powerful processing power of the microchips is leveraged to evolve smart and connected machines and systems, simultaneous breakthroughs are occurring in a wide array of fields. Klaus Schwab has identified the mega trends in three clusters; Physical, Digital & Biological. The three are intertwined with each other and progress in one is dependent on developments in the other fields. The clearly identifiable megatrends within these clusters are (Schwab, 2017):-

(a) **Physical**.

(i) **Autonomous Vehicles**. From driverless cars to drones in the air and sea, autonomous vehicles are set to become an ubiquitous part of our world. Advanced militaries are investing heavily into the technology, extending it to swarms controlled by one brain moving in synchronisation. A 132 foot long US Navy ship (The Sea Hunter) recently sailed from California to Hawaii & back without a single human on board. (Harkins, 2019) The implications for increase in endurance are significant. Not to be outdone China demonstrated a perfectly synchronized interception mission by 56 unmanned boats near the Wanshan islands in the South China Sea. (GlobalTimes, 2019)

(ii) **3D Printing**. Also called additive manufacturing it is the process of creating an object by adding layer upon layer based on a digital template fed into the memory of the 3D printer. 3D printing is becoming increasingly economical and is set to revolutionise manufacturing. In times to come it will become all pervasive producing complex machines and even human cells and organs. (Schwab, 2017) This technology can revolutionise military logistics as only a printer and raw materials need to be transported instead of a large inventory of spare parts and weapons. (Peels, 2017)

(iii) **Advanced Robotics**. From serving foods to repairing vehicles, robots are finally set to move from science fiction into our daily lives. In the military hazardous and fatiguing tasks such as IED disposal already employ robots and this utilization is set to see explosive growth in the future. As per the US Army's Robotic and Autonomous Systems Strategy they plan to have "self-aware" systems fully integrated by 2031, but even more interestingly robots may outnumber humans in the US Army by 2025. (Webb, 2018)

(iv) **New Materials**. Lighter, Stronger and with unimaginable attributes such as self-cleaning, self-healing & invisibility new materials are revolutionizing manufacturing. In the battlefield, lighter materials such as graphene with many times the strength of traditional materials and with self healing properties are set to

revolutionise armour. (Laskow, 2014) Reliance on metal ores may soon be a thing of the past for everything from combat vehicles to weapons. Nanomaterials which bend light completely have already made total invisibility a reality in laboratories, stealth will soon take on mythological proportions.

(b) **Digital**. The Internet of Things (IoT) is set to bridge the gap between the physical and digital worlds. Soon cheap, smart sensors will be installed in homes, clothes & accessories which will allow us to optimize assets and their activities at a very granular level. (Schwab, 2017) Blockchain is set to redefine security and will dominate all transaction activities in the future. Money is set to be digitized into virtual currencies such as Bitcoin. The most successful companies of today such as Uber, Alibaba and Air BnB do not even own any of the physical commodities they trade in. (Goodwin, 2015) Supply Chains are already being revolutionised with RFID technology connected to Big Data driven smart machines matching demand and supply efficiently with minimal human intervention. Virtual Networks seamlessly connect and control platforms as diverse as home cooling appliances and power generation plants. IoT is being exploited by advanced militaries to enhance battlefield awareness and improve interface between soldiers and smart machines. As per concept note published by the UK MoD in 2018, Human-Machine Teaming is the corner stone of the future soldier programme. (UK MOD, 2018)

(c) **Biological**. The Human Genome Project took 10 years and close to three billion dollars to complete, the same level of genome sequencing can be achieved today in a few hours for a few thousand dollars. This has given us the power to customize organisms. Synthetic biology in this manner has the potential to produce super organisms. Ethical considerations at present prevent nations from openly pursuing such programmes. The ethical, social and psychological challenges in this vertical are considerable and may take some time to resolve. However the capability for innovation exists and it will be a test of human patience and wisdom to resist the temptation to use the technology to gain an advantage over adversaries. US is known to have secret programmes aimed at producing 'Genetically Augmented' soldiers who can think, run and shoot faster, need no sleep, feel no pain and have synthetic blood running in their veins. (Nye, 2017)

12. Having considered the Mega Trends of the Fourth Industrial Revolution and some examples of their military manifestations let us briefly consider some domains and concepts which are likely to revolutionise warfare as we know it. The synergies between the physical, digital and biological aspects of the Fourth Industrial revolution have already manifested themselves and are transfiguring the battlefields of the 21st Century. David Barno & Nora Bensahel in a paper published online (David Barno, Nora Bensahel, 2018) and Paul Scharre in his book The Army of None (Scharre, 2018) have identified the concepts which will radically reconfigure warfighting:-

(a) **The Evolving Concept of Autonomy: AI, Big Data, Machine Learning driven Human-Machine Teaming & Fully Autonomous Platforms**. The US DARPA and the Chinese are known to have elaborate programmes devoted to building autonomous platforms which include vehicles, weapons and robots customised to perform diverse tasks. In the battlefield the implications are astounding. Sensor to shooter coordination is reaching unprecedented levels of efficiency, soon invisibility (both visual and electronic) at individual and massed levels will redefine our concept of 'Stealth', Operational Logistics will be revolutionised and Battlefield Transparency and Deception will enter an unprecedented digital race. Human-Machine Teaming has already been conceptualized by advanced militaries and effective integration of man & machine will give decisive advantage to adversaries in the future. (UK MOD, 2018) The weaponisation of Artificial Intelligence is giving rise to a generation of autonomous weapons which are minimising the role of the human in the loop. (Scharre, 2018) Peter Singer in his book Wired for War underlines the irretrievable chain of events the quest for autonomy sets into play. As the intelligence of the machines increases and the OODA loop gets shorter and

shorter the temptation to remove the human in the loop altogether will become difficult to resist once a stage is reached wherein he becomes the weakest link. (Singer, 2009) Hazardous tasks are the first logical area where entirely autonomous platforms would find employment. However as the speed & precision of autonomous platforms increases, operations enabled by these technologies would unfold at such a pace that effective responses would require removal of the humans from the decision making cycle altogether. (David Barno, Nora Bensahel, 2018) Countries are already moved a considerable distance down this road, as already explained, after air and land, the Pentagon is presently engaged in building a "Ghost Fleet" of Drone Ships capable of relentlessly patrolling the high seas, setting up a perimeter and identifying friend or foe without human intervention, for the time being the decision to engage identified enemies with lethal weapons remains vested with a shore based command facility manned by humans. (Mizokami, 2019) The powerful tactical & operational advantages such systems would offer are likely to set off a race amongst major powers to master them, those who fail to do so will inevitably end up on the losing side. The employment of fully autonomous machines would make decision making highly objective and remove the scope of 'human error', however the prospect of an autonomous machine taking the decision to take a human life is fraught with moral and ethical issues. Yet we know that technology has been known to shape warfare and once it comes into being, throughout history there is little evidence to establish that mankind has been able to resist the temptation to use it to establish a decisive advantage over his adversary. (Roland, 2009)

(b) **Re-Shift of Doctrines from Precision to Mass**. In the third industrial revolution one of the pre-dominant themes has been the employment of high precision weapons capable of surgical strikes and counter measures against them such as Ballistic Missile Defence. However such technology continued to be exorbitantly expensive. With reduction in cost and coming together of AI and robotics, militaries will be able to scale mass, extend reach and persistence and exploit information advantage. (UK MOD, 2018) As an example, a major emerging trend of the Fourth Industrial Revolution are smaller, smarter and cheap massed weapons such as Drone Swarms which are intelligent and capable of penetrating the densest defensive environments. A major emerging operational and tactical reality of this emergent threat would be that even minor powers would be able to indulge in a new form of guerilla warfare and defence against such attacks would have to be prioritized. Flying tactical IEDs could emerge as a major tool of asymmetric warfare. Cheap 3-D printing could enable insurgents to quickly manufacture a drone capable of harassing the forces, paired with off the shelf GPS on a smartphone it would cost only about $500 today and the costs are set to fall further. (Hammes, 2016)

(c) **Space and Cyber**. While Space and Cyber domains emerged as key potential theatres of war in the Third Industrial Revolution, they have never really been contested fully. (David Barno, Nora Bensahel, 2018) As a result there are no case studies or lessons learnt of full-fledged conflicts in these domains yet. However in the future with dependencies for the functioning of assets mentioned above on support from these domains, targeting them would not only be important but also considered fair game. India's recent ASAT test is a result of growing realisation that such a capability is no longer just desirable but essential. (Pubby, 2019) A conflict in these domains could have debilitating effects on the conventional warfighting capabilities of forces due to the overwhelming dependence of vital support systems on space and cyber assets. Setting up of Command and Control structures for these domains therefore becomes important.

(d) **Disruptive High-Tech Weapon Technologies**. Hyper Velocity Projectiles, Directed Energy Weapons and Rail Guns are examples of just some of the high technology that has been weaponised already. The Pentagon has confirmed plans to deploy a Directed Energy Weapon (based on Neutral Particle Beam) in space which would be capable of destroying enemy missiles seconds after takeoff. (Mizokami, 2019) Similarly deployment of Laser guns onboard ships is at an advanced stage. China's warship mounted Rail Gun capable of

sinking carriers upto 150 km away went to sea trials in 2018. It is capable of launching projectiles at speeds upto 7 Mach and can bypass all existing defensive systems. (Elliott, 2019) These and many more such technologies are upgrading weapon systems to unprecedented levels of speed, range and destructive power. Any major power that wishes to be a serious contender in the military space cannot afford to remain invested in legacy systems, which may prove to be entirely ineffective in a future conflict.

(e) **The X Factor**.Over and above the discernible defence technologies which are becoming a reality, a large number of 'magical' ones may surprise adversaries in future conflicts. The US, China, Russia and EU are known to be running many secret projects for development of futuristic weapons. Especially the increased understanding of quantum physics may unleash wizard-like powers such as bending of light and levitation. Already invisibility cloaks are a reality thanks to the advent of meta-materials. (IOP, 2016) China has commenced cloaking not only its new stealth fighters such as the J-20 but also its existing fleet with invisibility cloaks made out of metamaterials which can make them invisible to all sensors. (Kenhmann, 2018) A soldier of the future may be disease resistant, have super human endurance and be able to accelerate healing of wounds. Many other technologies are transitioning from the realm of sci-fi to reality and are likely to add an X-Factor to future warfare.

The Way Forward

13. Given the rate and scale of the oncoming change, the challenges in front of military leaders are monumental, but so are the opportunities. Flexibility of though and the ability not only to learn but also to unlearn will be key competencies that will separate the successful leaders from others. While the Principles of Warfare may remain same, but their practical manifestation will be redefined in often unrecognisable ways.

14. If we have to not only survive but thrive in the coming world, we must put into place structural changes which mirror the changed realities. As explained, as technology changes commensurate changes must also be made in People, Tasks and Structures. Some identified measures are:-

(a) **Awareness**. Awareness is the first step towards coping with the discomfort change brings. Leaders must make a concerted drive to spread awareness on the quanta of the oncoming disruptive change and the need to adapt to it. Leaders must incorporate Change Management as a key mission in the Vision Statement of the Armed Forces. Commanders at all levels must be sensitized on the nature of expected change, its rapidity and how to cope with it.

(b) **Communication**. In times of disruptive change, communication must be maximized. Leaders at all levels must be educated on the disruptive scale of the oncoming change and be able to convey the same to all members of the organisation.

(c) **Create a Guiding Coalition**. Leaders require allies at all levels which include other leaders as well as managers to support and progress change. (Kotter, 1996) A large number of change efforts fail due to centralized ownership, leaders must therefore avoid this trap. Suitable functionaries at all levels must be co-opted and aligned with the chage effort.

(d) **Reform Structures**. As given by Leavitt (Leavitt, 1965), if technology changes without the concomitant changes in structures the organisation risks becoming incoherent. Leaders must therefore concurrently evolve suitable structures and transit to them. In a bureaucratic set up this presents a challenge and

is time consuming and must therefore be pursued with vigour, the preceding measures would greatly facilitate efforts in this regard.

(e) **Create Competencies**. A key aspect of one of the other key elements of Leavitt's diamond "People" need to be invested into. Newer competencies suitable for the Fourth Industrial Revolution must be sought out or created.

(f) **Invest in R & D**. The difference between those who have access to the technologies of the Fourth Industrial revolution and those who do not, could very well be the same as that between the colonisers and the enslaved of the 17th & 18th centuries. Developing own technologies, learning from others and innovating- India must invest capital into these efforts on priority. The cost to pay for a failure to do so would be heavy.

(g) **Institutionalise the Change Process**. Change in the Indian context has been personality driven and sporadic. This must change and a process must be consciously adopted. John Kotter and Kurt Lewin have provided excellent frameworks for change implementation. However a tailor-made process must be consciously chosen after due analysis and formally adopted. One such step-wise methodology (Kapoor, 2008) has been articulated by Colin S Gray (Gray, 2002):-

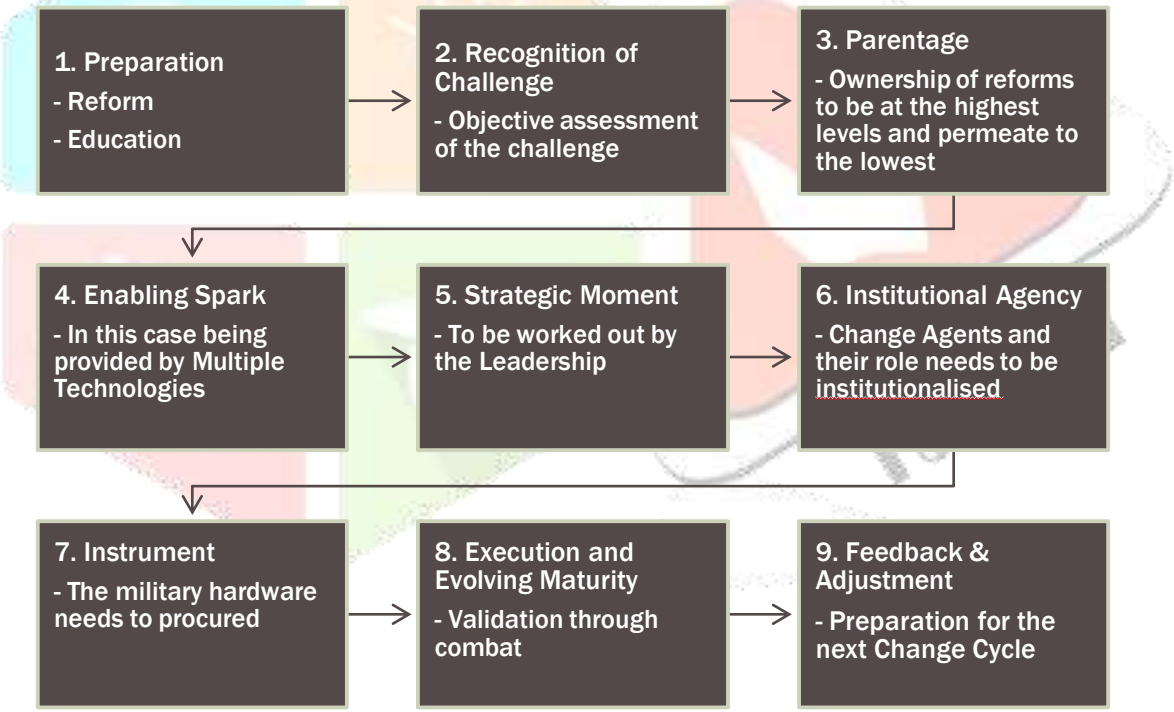

Fig 4: A Sample Change Management Process for Managing RMA

Conclusion

15. Alvin Toffler's prediction in his 1970 book Future Shock continues to hold good with regard to the leadership challenges the 'super industrialised society' is creating and the resultant psychological dislocation. (Toffler, 1970) Today's strategic leadership faces a formidable challenge in terms of the rapidly changing environment they have to operate in. The prevalent environment of extreme Volatility, Uncertainity, Complexity and Ambiguity requires leaders to operate flexibly in multiple time domains to manage change so

as to mitigate the challenges and leverage the opportunities that it throws up. They need to be able to visualize the future, formulate and articulate a future ready vision for their organisations.

16. The victors of tomorrow will be distinguished from the vanquished by the ability or otherwise of their leaders to understand and cope with the unprecedented change that the unrelenting march of technology is forcing upon the profession of arms.

References

Erik Brynjolfsson & Andrew McAfee, 2016. *The Second Machine Age.* 2nd ed. New York: W.W Norton & Company.

Alden, E., 2017. *Failure to Adjust.* 1st ed. London: Rowman & Littlefield.

Arnold Thackray, David C Brock, Rachel Jones, 2015. *Moore' Law.* 1st ed. New York: Basic Books.

David Barno, Nora Bensahel, 2018. *www.warontherocks.com.* [Online]
Available at: https://warontherocks.com/2018/06/war-in-the-fourth-industrial-revolution/
[Accessed 28 March 2019].

Elliott, J. K., 2019. *www.globalnews.ca.* [Online]
Available at: https://globalnews.ca/news/4810853/china-railgun-warship-weapon/
[Accessed 30 March 2019].

GlobalTimes, 2019. *Global Times News.* [Online]
Available at: https://twitter.com/globaltimesnews/status/1002082247736885248
[Accessed 24 March 2019].

Goodwin, T., 2015. *www.techcrunch.com.* [Online]
Available at: https://techcrunch.com/2015/03/03/in-the-age-of-disintermediation-the-battle-is-all-for-the-customer-interface/
[Accessed 27 March 2019].

Gray, C. S., 2002. *Strategy for Chaos.* Digital ed. London: Frank Cass Publishers.

Hammes, T. X., 2016. *www.warontherocks.com.* [Online]
Available at: https://warontherocks.com/2016/10/the-democratization-of-airpower-the-insurgent-and-the-drone/
[Accessed 29 March 2019].

Harkins, G., 2019. *www.military.com.* [Online]
Available at: https://www.military.com/defensetech/2019/02/15/navy-ship-sailed-hawaii-and-back-no-one-on-board.html
[Accessed 26 March 2019].

IOP, 2016. *www.iop.org.* [Online]
Available at: www.iop.org/resources/topic/archive/metamaterials/
[Accessed 30 March 2019].

Kapoor, V. K., 2008. *www.idsa.in.* [Online]
Available at: https://idsa.in/jds/2_2_2008_RMAandIndiaMilitaryTransformation_VKKapoor
[Accessed 03 April 2019].

Kenhmann, H., 2018. *www.popsci.com.* [Online]
Available at: https://www.popsci.com/chinas-new-stealth-fighter-uses-metamaterials
[Accessed 30 March 2019].

Kotter, J. P., 1996. *Leading Change.* 1st ed. Harvard: Harvard Business School Press.

Kurzweil, R., 2000. *The Age of Spiritual Machines.* 2nd ed. New York: Penguin Group.

Laskow, S., 2014. *www.theatlantic.com.* [Online]
Available at: https://www,theatlantic.com/technology/archive/2014/09/the-strongest-most-expensive-material-on-earth/380601/
[Accessed 27 Mar 2019].

Leavitt, H., 1965. *Handbook of Organisations.* s.l.:s.n.

Mizokami, K., 2019. *www.popularmechanics.com.* [Online]
Available at: https://www.popularmechanics.com/military/weapons/a26858944/pentagon-particle-beam-space-2023/
[Accessed 29 March 2019].

Mizokami, K., 2019. *www.popularmechanics.com.* [Online]
Available at: https://www.popularmechanics.com/military/navy-ships/a26827544/us-navy-ghost-unmanned-warships/
[Accessed 29 March 2019].

Morgan, G., 1986. *Images of Organisation.* 1st ed. Newbury Park: SAGE.

Nye, L., 2017. *www.businessinsider.com.* [Online]
Available at: https://www.businessinsider.com/8-technologies-the-pentagon-puruing-create-super-soldiers-2017-7?IR=T
[Accessed 08 April 2019].

Peels, J., 2017. *www.3dprint.com.* [Online]
Available at: https://3dprint.com/165561/3d-printing-in-the-military/
[Accessed 26 Mar 2019].

Pubby, M., 2019. *www.economictimes.com.* [Online]
Available at: https://economictimes.indiatimes.com/news/politics-and-nation/pm-modis-big-announcement-india-succesfully-tests-anti-satellite-weapon/articleshow/68592702.cms?from=mdr
[Accessed 29 MArch 2019].

Roland, A., 2009. *War and Technology*. [Online]
Available at: https://www.fpri.org/article/2009/02/war-and-technology/
[Accessed 21 March 2019].

Scharre, P., 2018. *Army of None.* 1st ed. s.l.:W W Norton & Company.

Schwab, K., 2017. *The Fourth Industrial Revolution.* 1st ed. New York: Penguin.

Singer, P. W., 2009. *Wired for War*. 1st ed. London: Penguin Books Ltd.

Toffler, A., 1970. *Future Shock*. 1st ed. s.l.:Random House.

Udi Manber, Peter Norvig, 2012. *http://insidesearch.blog.* [Online]
Available at: http://insidesearch.blog-spot.com/2012/08/the-power-of-apollo-missions-in-single.html
[Accessed 25 Dec 2018].

UK MOD, 2018. *Joint Concept Note 1/18 Human-Machine Teaming.* London: UK MOD.

Webb, W., 2018. *www.mintpressnews.com.* [Online]
Available at: https://www.mintpressnews.com/the-u-s-military-will-have-more-robots-than-humans-by-2025/237725/
[Accessed 26 March 2019].